REMARKS

Claims 1-20 are currently pending in the subject patent application. In the subject Office Action, the Examiner rejected claims 1-20 under 35 U.S.C. 103(a) as being unpatentable over Ward (U.S. Patent Number 5,996,406), since the Examiner stated that Ward discloses an advanced signal processing technique which accurately discriminates and estimates a small sinusoidal signal in close proximity from one or more large sinusoidal signals, by using digital processing techniques to accurately estimate the frequency (96), amplitude (94) and phase (98) of the one or more large sinusoids and then using this estimate to obtain an accurate estimate of the small sinusoidal signal by subtracting the large sinusoid from the data to obtain a residual, and reprocessing the residual.

With regard to claim 1, the Examiner continued that in Figs. 1 and 2, Ward discloses and shows an apparatus for measuring liquid level in a container which comprises in combination: (a) a device (10) in physical-contact with the outside of a wall of the container (12) for generating at least two acoustic resonance responses in the liquid substantially perpendicular to the surface; (b) a sweep generator (**40** in FIG. 2) for electrically exciting said device over a chosen range of acoustical frequencies and having a chosen waveform; and (c) a receiver for measuring the acoustic frequencies for at least two resonant responses.

With regard to claims 2 and 9, the Examiner stated that the sweep generator is disclosed to generate a sinusoidal signal; thus, a sine wave is disclosed.

With regard to claims 3-5 and 10-12, the Examiner stated that though these exact parameters of the calculation are not specifically disclosed, use of, for example, a Fast Fourier Transform, which is a time domain measurement, a specific resonance, or the sine function given, is just one of many time domain techniques that may be used by one of ordinary skill in the art to determine a travel time and/ or interpret data from a level system, and would therefore be an obvious design choice for the circuitry for the device to operate depending on the specific desire of the user. For example, the Examiner continued, Col. 4, line 30 through Col. 5, line 14 describe various methods that may be used to interpret data obtained by the Ward system, of which one is the discrete Fourier transform (DFT), and even the

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disadvantages of using the DFT method. The Examiner then concluded that the use of various formulas and algorithms to determine the liquid level would be obvious to one of ordinary skill in the art.

Applicants respectfully disagree with the Examiner on these grounds of rejection for the reasons to be set forth hereinbelow.

With regard to claim 6, the Examiner stated that Ward discloses and shows in Figs. 1 and 5 an apparatus for measuring liquid level in a container which comprises in combination: (a) means (10) in physical contact with the outside of a wall of the container (12) located below the surface of the liquid for generating at least two acoustic resonance responses in the liquid substantially perpendicular to the surface, and for determining the acoustic frequencies of at least two resonant responses; and (b) means for electrically exciting said means for generating at least two acoustic resonance responses over a chosen range of acoustical frequencies and having a chosen waveform (40).

Applicants fail to understand the Examiner's rejection of claim 6, since there is no Fig. 5 in Ward, and Ward does not mention an acoustic response generated in the liquid below the surface thereof.

With regard to claim 7, the Examiner stated that the means for generating the two at least acoustic responses and for determining said acoustic frequencies of said responses comprises an acoustic transducer and acoustic receiver.

With regard to claim 8, the Examiner stated that a sweep generator is disclosed (40).

With regard to method claims 13-16, the Examiner stated that though the method is not explicitly spelled out, since the apparatus parameters appear to be disclosed, then the method to operate such a device would also be obvious to one of ordinary skill in the art in view of the prior art.

Applicants respectfully disagree with the Examiner on these grounds of rejection for the reasons to be set forth hereinbelow.

With regard to claims 17, 18, and 19, the Examiner stated that these claims are more broad recitations of the apparatus claims above, and the Examiner feels

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that since the specific, more narrow claims are disclosed, and then the broad, general apparatus is disclosed as well.

Applicants fail to understand the Examiner's ground of rejection of claims 17, 18, and 19.

With regard to claim 20, the Examiner stated that Ward discloses a method for measuring liquid level in a container, which comprises the steps of: (a) generating at least two acoustic resonances in the liquid substantially parallel to the surface of the liquid, and (b) detecting the presence of acoustic resonances from the liquid. This is generally disclosed in Col. 2, line 32, through Col. 3, line 65.

Applicants respectfully disagree with the Examiner concerning this ground of rejection for the reasons to be set forth hereinbelow.

Reexamination and reconsideration are respectfully requested.

Briefly, the present invention includes an acoustic-based, frequency domain apparatus and method for liquid level detection. FIGURE 1 of the subject patent application is a schematic representation of an embodiment of the invention where standing waves are generated in an acoustic cavity formed by the surface of the liquid acting as a reflector and a transducer for introducing vibrational energy into the liquid external to and through a wall of the container holding the liquid. The standing waves generated in the liquid are detected using a transducer either located nearby to, or collocated with the energy transmitting transducer or by the energy transmitting transducer itself, and the response of the system is measured as a function of frequency. More particularly, claim 1 recites: "An apparatus for measuring liquid level in a container which comprises in combination: a transducer in physical contact with the outside of a wall of the container located below the surface of the liquid for generating at least two acoustic resonance responses in the liquid substantially perpendicular to the surface; a sweep generator for electrically exciting said transducer over a chosen range of acoustical frequencies and having a chosen waveform; and a receiver for measuring the acoustic frequencies for at least two resonant responses."

Turning now to the Ward patent, in Col. 1, lines 22-28 of Ward, it is stated that: "First and foremost, if the material to be monitored is non-conducting and has a

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low dielectric constant, then the RF energy can penetrate the fluid and be reflected from whatever is below the surface of interest that is opaque to the RF signal. This could be the bottom of the tank, or it could be some other fluid (such as water for example) that is opaque to the RF signal."

In Col. 2, lines 24-48, of Ward it is stated that: "Device **10** is typically coupled to storage tank **12** via standpipe **16** whereby RF signals are transferred between apparatus **10** and storage tank **12** via glass **18**. Storage tank **12** includes surface **22**, which represents the bottom surface of tank **12** that represents an RF opaque surface. Altemately, tank **12** may also include material **20**, for example, water, that is opaque and, thus, reflects RF signals. Briefly, when an RF signal is transmitted from apparatus **10** into tank **12**, it will first reach low dielectric interface **24** which causes a small reflection of the RF signal whereby much to the RF signal is still transmitted through material **14**. This RF signal will then eventually reach RF opaque interface **26** (or bottom surface **22** if material **20** is not present) and this will reflect most of the RF signal back to device **10**. As discussed above, the problem faced with the present invention is to be able to distinguish the sinusoid signals being reflected from surface **24** of material **14** and surface **22** of the bottom of the tank (or surface **26** of material **20**, if present) whereby typically the signal of interest is the one being reflected from interface **24**, but this signal is typically much smaller than the being reflected from the RF opaque interface. It is this signal reflected from surface **24** will allow one to determine the level of material **14** within tank **14**."

The Examiner has stated in the subject Office Action that though the device is not explicitly disclosed to be a transducer, the device is disclosed to emit RF signals and perform a level measurement based upon transmitted and reflected signals, which would make this an ultrasonic type device, and that it is well known in the liquid measurement art that transducers, piezoelectric crystals, ultrasonic transmitters, and radar type level measurement devices are established equivalents for performing the same function of emitting a signal and receiving the reflected signal to determine liquid level. The Examiner then concluded that the use of a transducer as the transmission element for Ward would be considered obvious to one of ordinary skill in the art at the time of the invention. The Examiner also noted

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that the Ward device has the signal generation means located at the top of the tank and not at the bottom as claimed, but that the position of the transmitter is more of a factor of convenience than performance as the position of the transmitter/receiver does not change the performance of the device, and therefore, though not in the exact orientation as claimed, the Ward reference is still deemed as prior art since the device performs in the same fashion and there is no disclosure shown any advantage resulting from changing the position, nor any unexpected result stemming from positioning the transducer element at the bottom of the tank.

Applicants respectfully disagree with the Examiner concerning this analysis. First, there is no similarity between acoustic waves, which are mechanical or pressure waves, where the pressurizations and rarifications move in the direction of propagation or opposite thereto, and an electromagnetic wave, where the variation in electric or magnetic fields are perpendicular to the direction of travel of the wave. For example, as stated in Ward, RF will not substantially penetrate high dielectric constant materials, such as water. By contrast, acoustic waves readily penetrate water.

Second, the location of the source of excitation is critical for Ward. If the RF source of Ward was placed below the liquid to be measured, no signal would be measured if the liquid was water. Therefore, the present invention specifies that the source of acoustic excitation is below the surface of the liquid for which the height is to be measured, while such location would clearly not result in meaningful information for liquids having high dielectric constants if one were practicing the invention disclosed in Ward.

Thus, applicants believe that Ward teaches away from the present claimed invention.

Moreover, RF waves do not excite acoustic resonances in the liquid, as required by the present claimed invention. As described in the subject Specification, as originally filed, by combining the sound speed, *c*, of the liquid (c = 780 m/s for propane) and a measurement of Δf from the spectral response, the distance between the wall on which the transmitter/receiver pair is affixed and the liquid surface is readily continuously determined from the relation

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$L = \frac{c}{2\,\Delta f}$ of the present invention, thereby permitting a continuous liquid level to be measured and monitored. By contrast reflections from the various surfaces are required for the invention of Ward to determine the height of the subject liquid.

Again, applicants believe that Ward teaches away from the subject claimed invention, and that the Examiner has not made a proper *prima facie* showing of obviousness as is required under 35 U.S.C. 103(a). Reexamination and reconsideration are respectfully requested.

In view of the discussion presented hereinabove, applicants believe that subject claims 1-20 are in condition for allowance or appeal, the former action by the Examiner being earnestly solicited at an early date.

Respectfully submitted,

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